HTM 2045 Acoustics

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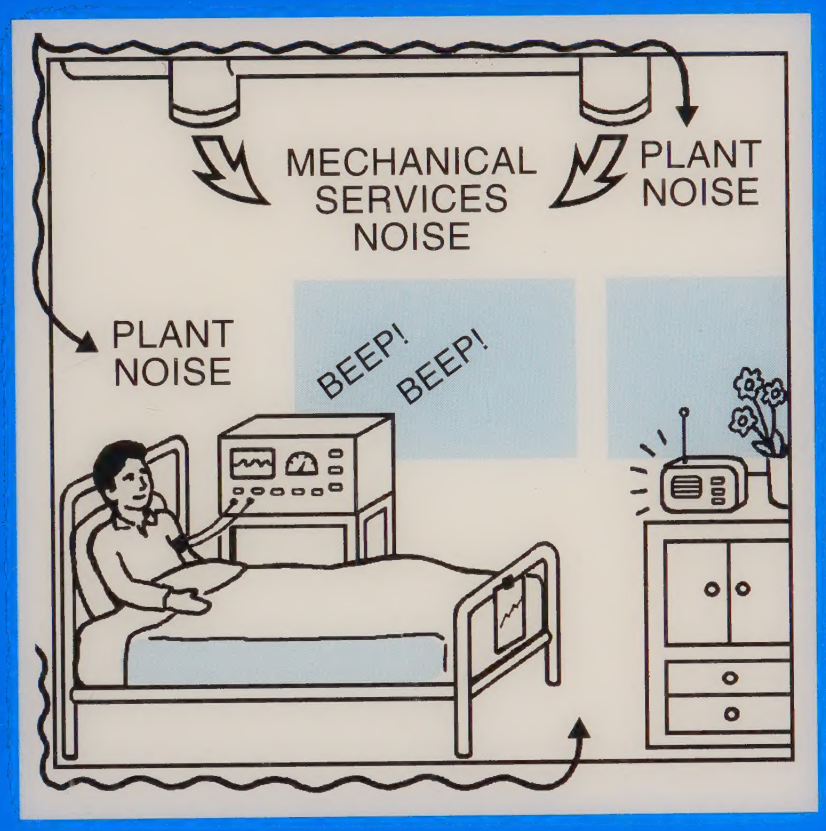
Acoustics

Management policy

Health Technical Memorandum 2045



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Health Technical Memorandum 2045

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The price of this publication has been set to make some contribution to the costs incurred by NHS Estates in its preparation.

About this publication

Health Technical Memorandum (HTM) 2045 – 'Acoustics' is mainly applicable to new sites, but measures have sometimes been given which could also be applied retrospectively to existing buildings. It gives advice and guidance to healthcare management, design engineers, estates managers and operations managers on the legal requirements, design implications, maintenance and routine measures which should be adopted.

HTM 2045 is published as four separate volumes, each addressing a specialist discipline:

- this volume – **Management policy** – details overall responsibility of managers of healthcare premises and details their legal obligations to control noise in healthcare premises.

- **Design considerations** – does not set out to give instruction in design work, but highlights the overall requirements and considerations that should be applied to noise control;

- **Validation and verification/ Operational management** – provides information on the commissioning process, routine maintenance and monitoring;

- **Audiology** – relates specifically to acoustic considerations of audiology suites. The document covers management policy, design considerations, validation and verification and operational management.

The contents of this Health Technical Memorandum in terms of management policy, operational policy and technical guidance are endorsed by:

a. the Welsh Office for the NHS in Wales;

b. the Health and Personal Social Services Management Executive in Northern Ireland;

c. the National Health Service in Scotland Management Executive.

This HTM was written with the advice and assistance of experts in the NHS and industry.

Executive summary

Acoustics in healthcare premises requires careful consideration. Noise becomes a health hazard when people are exposed to it in large quantities and when it becomes intrusive to an extent that staff and patients are put under stress.

Management has a duty to control noise as a requirement for patient care and wellbeing, and in order to fulfil statutory duties imposed by the following legislation:

The Noise at Work Regulations 1989 (NAW Regs) are aimed at protecting the hearing of employees exposed to noise. Employers have a duty to reduce the risk of hearing damage as far as reasonably practicable within the area under their responsibility. Measures need to be taken when noise levels exceed threshold levels termed "Action Levels". At the First Action Level, employers must provide for a noise assessment of the workplace. Information for workers on the potential for hearing damage, and adequate properly maintained ear protection, must be made available for those who request it. Employers must ensure that all equipment (with the exception of ear protectors) provided under the Regulations is used. At the Second Action Level and the Peak Action Level, the above apply, and also the requirement to mark ear protection zones and reduce exposure to noise by engineering methods. Ear protection must be worn in ear protection zones.

The Control of Pollution Act 1974 can initiate restrictions on the use of a premises if noise or other function is considered to be a nuisance by local authorities.

The Health and Safety at Work etc Act 1974, on the other hand, requires the person responsible to ensure that audible warning sounds can be heard and to safeguard people on the premises who are not at work.

Staff and patient performance, wellbeing and recovery will benefit from a suitable noise climate. Consideration of the acoustic environment both internally and externally is a management responsibility. Internally, high noise levels make communication difficult and conditions stressful for staff and patients alike. If noise levels are too low, privacy may be compromised and patients may feel isolated.

Management must ensure that a site does not become a nuisance to the external environment. Site activities can be restricted legally if noise from the site is not controlled.

Noise break-in from exterior to interior can be controlled by the provision of an adequate building envelope. Plant and machinery noise and vibration can be controlled using engineering methods.

Acoustic measurement is given in terms of decibels (dB) which increase on a logarithmic scale. The human ear does not perceive all frequencies of sound to the same extent; to allow for this, a weighting correction is applied to dB measurements.

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1.0 Introduction

1.1 Acoustics in healthcare premises requires careful consideration for many reasons. Management have statutory requirements, for example to control noise exposure to workers, along with other responsibilities to provide an environment suitable for the various activities undertaken in hospitals.

1.2 Health Technical Memorandum (HTM) 2045 – 'Acoustics' is published in four separate volumes. It is mainly applicable to new sites, but measures have sometimes been given which could also be applied retrospectively to existing premises. It gives comprehensive advice and guidance to healthcare management, design engineers, estates managers and operations managers on the legal requirements, design implications, maintenance and routine measures which should be adopted.

1.3 Noise becomes a health hazard when people are exposed to it in large quantities and when it becomes intrusive to an extent that patients and staff are put under stress. Staff work more efficiently, and patients may recover more quickly, if their noise environment is appropriate.

1.4 Noise must be controlled in a number of ways. For example, the interior noise environment must be sufficiently insulated against local exterior noise sources. Conversely, the site must not significantly affect the exterior noise environment.

1.5 Noise from any activity within the premises should not appreciably intrude on other activities. This requires careful positioning of rooms in relation to one another, or provision of sufficient sound insulation for the purpose.

1.6 In rooms where communication is important, or low noise levels are essential, additional factors need to be taken into account. For example, proprietary acoustic materials on walls may be required to ensure that speech is intelligible and noise levels created in the room itself do not build up.

1.7 In general, the term "noise" also encompasses "vibration".

1.8 This HTM replaces any acoustic guidance given previously in other NHS Estates publications.

2.0 Management responsibilities

Statutory requirements

The Noise at Work Regulations 1989

2.1 The Noise at Work Regulations 1989 (NAW Regs) are an important piece of legislation aimed at protecting the hearing of employees exposed to noise. Employers have a general duty to reduce the risk of hearing damage as far as reasonably practicable within areas under their responsibility.

2.2 Once certain noise level thresholds have been reached, certain measures must be actively taken to reduce noise levels below these thresholds. The thresholds are termed "Action Levels".

2.3 At the First Action Level, employers must provide for a noise assessment of the workplace. Information must be provided to workers on the potential for hearing damage, and adequate, properly maintained ear protection must be made available for those who request it. Employers must ensure that all equipment (with the exception of ear protectors) provided under the Regulations is used.

2.4 At the Second Action Level and the Peak Action Level, the above paragraph applies, along with the requirement to mark ear protection zones and reduce exposure to noise by engineering methods. Ear protection must be worn in all ear protection zones.

2.5 The NAW Regs are most likely to apply to maintenance staff working in noisy plant areas.

The Health and Safety at Work etc Act 1974

2.6 The Health and Safety at Work etc Act 1974 (HSW Act) contains more general duties regarding noise. An example of when action might be needed under the HSW Act would be if the audibility of warning sounds were impaired by high background noise. Reference should be made to 'Firecode' (NHS Estates/HMSO) for issues relating to warning sounds in general.

The Control of Pollution Act 1974

2.7 The Control of Pollution Act 1974 (CPA) gives powers to local authorities to set noise criteria within the local environment. The local authority therefore has the power to serve notices on those responsible for causing noise amounting to a nuisance.

The Environmental Protection Act 1990

2.8 The Environmental Protection Act 1990 (EPA) amends parts of the CPA with general regard to statutory nuisances, including noise nuisances. The CPA deals more fully with various different aspects of noise such as construction sites and noise abatement zones, whereas the EPA deals more generally with "Statutory Nuisances and Clean Air", of which noise is a part. These two Acts should be used in conjunction with each other.

The Noise and Statutory Nuisance Act 1993

2.9 The existence of one further Act should be known. The Noise and Statutory Nuisance Act 1993 is not directly relevant to healthcare premises, but will be to associated activities. It covers nuisances arising from vehicle and building alarms, loudspeakers and other noise in public areas.

Other responsibilities

2.10 The management's general responsibility to patients and staff implies consideration of the acoustic environment both internally and externally. Staff and patient performance, wellbeing and recovery should all benefit from a suitable noise climate.

2.11 Internally, problems can occur if, at one extreme, high noise levels make communication difficult and conditions stressful for staff and patients alike. Conversely, if noise levels are too low, privacy may be compromised and patients may feel isolated. Noise levels within healthcare premises will also depend, for example, on local circumstances; that is, whether the premises are located in a city or the countryside.

2.12 The appropriate acoustic environment for a particular room or building depends largely on the anticipated use of the room. Some rooms which have critical requirements for speech intelligibility such as operating theatres, require specialised treatment of the walls and ceilings. For example, the reverberation time in such rooms is extremely important, and different surface finishes can help to achieve suitable design criteria.

2.13 A site must not be or become a nuisance to the external environment. Often, people will look to noise for a reason to complain about an activity if they feel

aggrieved by it for any other reason. BS 4142: 'Method of rating industrial noise affecting mixed residential and industrial areas' can be used to predict the likelihood of complaints from site neighbours. Site activities can be restricted legally if noise from the site is not carefully controlled.

2.14 If audiological areas are to be included in premises, special consideration has to be given to some strict and unique requirements. These include exceptionally quiet ambient noise levels and special internal acoustic conditions. The 'Audiology' volume of this HTM is dedicated to audiological areas and should be referred to for guidance.

2.15 Noise control by "engineering methods" is the preferred treatment for controlling plant and ventilation-system noise, both internally and externally. These methods include vibration isolation to reduce structure-borne noise and vibration, attenuators for heating and ventilation ductwork, and adequate building envelopes to control noise "break-out" and "break-in".

Operational management

2.16 To comply with the NAW Regs, an employer must continually take steps to reduce noise levels as far as reasonably practicable. This includes regular monitoring of noise levels in "noisy" environments. Noise at work surveys should normally be carried out at regular intervals; the frequency of these intervals depends on individual circumstances and how "at risk" the workers are. This can be ascertained once the first survey has been done. If exposure levels are close to the prescribed limits, it may be necessary to monitor them closely on a frequent basis. Surveys should be carried out by a competent test person or acoustic specialist.

2.17 Any noise control devices which may be required to reduce levels by engineering methods (as required at the Second Action Level in the NAW Regs) are largely passive and require little, if any, performance monitoring. Simple maintenance and cleaning is normally all that would be needed.

Designated staff functions

2.18 A person intending to fulfil any of the staff functions specified below must be able to prove that they possess sufficient skills, knowledge and experience to properly perform their designated tasks. This requirement also forms part of some of the regulations described in the above sections.

2.19 Management – management is defined as the owner, occupier, employer, general manager, chief executive or other person who is ultimately accountable for the safe operation of the premises.

2.20 Acoustic specialist – a person appointed or contracted by the management to advise on matters concerning acoustics, noise and vibration.

2.21 Competent test person – a person appointed or contracted by the management to carry out acoustic, noise and vibration tests and surveys. This person would normally be an acoustic specialist.

2.22 Maintenance person – a member of the maintenance staff, or noise control equipment manufacturer or installer, employed by the general manager to carry out maintenance duties on noise control equipment installations. The maintenance of, for example, the attenuators on ventilation ducts would normally be done by the person responsible for maintaining the ventilation system.

2.23 Contractor – the person or organisation responsible for the supply of the noise control equipment, its installation, commissioning and validation as appropriate. This person would not normally be a member of the general manager's staff.

3.0 Functional overview

Terms in use

3.1 Where this document generally refers to "noise", it is normally anticipated that "vibration" may also be a consideration. A general explanation of the terms is given below in a non-technical form.

Vibration

3.2 Vibration is induced in buildings and other structures when, for example, a machine has moving parts. The moving parts may be unstable, by design or otherwise, and if this is not properly controlled, vibration can be induced in a structure. This may be felt by occupants, cause malfunction in sensitive equipment or, in a severe form, cause structural damage by fatigue. Once vibration gets into a structure, noise can be radiated via the structure and reach areas some distance away from the vibration source.

Noise

3.3 Noise is normally defined as "unwanted sound".

Acoustic parameters

3.4 Most acoustic measurements are given in terms of the decibel (dB). The decibel scale is logarithmic; that is, it cannot be manipulated in conventional arithmetical ways. For example, 45 dB + 45 dB equals 48 dB, not 90 dB.

3.5 The human ear does not perceive all frequencies of sound to the same extent. For this reason, a weighting correction is sometimes applied to dB measurements, the most common being the "A-weighting". Subscript "A" or dB(A) is afffixed to any parameters when this is the case.

3.6 L_{90} (or L_{A90} if A-weighted) is the symbol used to denote background noise level. It is defined as the sound pressure level in dB which is exceeded for 90% of the measurement period. Similarly L_{10} is the sound pressure level which is exceeded for 10% of the measurement period. L_{10} is normally used as a descriptor for road traffic noise levels.

3.7 L_{eq} is the "equivalent continuous sound pressure level" and corresponds to the steady sound level over a period of time which would contain the same total sound energy as the varying noise under consideration for the same period of time. It can be considered as the "average" noise level.

3.8 Noise rating (NR) criteria are a series of curves used to describe noise. They enable a noise spectrum to be described by a single number, and are particularly useful for noise from mechanical services plant and heating and ventilation systems.

3.9 Reverberation time (RT) is a measure of the time it takes sound in a room to die away after it has stopped. It is defined as the time in seconds it takes for the sound level to drop by 60 dB. Alternative symbols include T60, RT60 and T_R.

Others

3.10 "Acoustic environment" or "acoustic climate" is a general description of the complete acoustic nature of an area. It could be described using acoustic parameters such as L_{A90}, LAeq, NR and RT (see above for basic descriptions of these parameters).

Noise control requirements

3.11 Noise break-in from exterior to interior can be controlled by provision of an adequate building envelope, that is, walls, windows or roof. Design requirements depend on individual cases, and acoustic advice needs to be incorporated at the building design stage for the most cost-effective solutions.

3.12 Plant and machinery noise and vibration can be controlled in a variety of ways, again depending on the specific requirements. For example, anti-vibration mounts are used to reduce machinery vibration which could cause structure-borne noise. Attenuators are put into ductwork systems to reduce noise transmitted through such systems.

4.0 Management action

4.1 The guidance in this HTM should be applied in full to all new installations, and retrospectively where possible.

4.2 Noise control will need to be provided:

a. as a requirement for patient care and wellbeing;

b. in order to fulfil a statutory duty.

4.3 The statutory need for noise control is summarised below:

a. the Noise at Work Regulations 1989 require employers to reduce the risk of hearing damage as far as reasonably practicable at all levels. At high noise levels, action must be taken to protect the hearing of workers by appropriate methods;

b. the Health and Safety at Work etc Act 1974 requires the person responsible to ensure that audible warning sounds can be heard and to safeguard people on the premises who are not at work;

c. the Control of Pollution Act 1974 can initiate restrictions on the use of a premises if noise or other function is considered to be a nuisance by local authorities.

4.4 It is a management responsibility to ensure that an appropriate acoustic environment is provided and maintained.

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Part 1: 1980 (1993) Recommendations for laboratories

Part 2: see BS EN 20140-2: 1993

Part 3: 1980 (1993) Laboratory measurements of airborne sound insulation of building elements

Part 4: 1980 (1993) Field measurements of airborne sound insulation between rooms

Part 5: 1980 (1993) Field measurements of airborne sound insulation of facade elements and facades

Part 6: 1980 (1993) Laboratory measurements of impact sound insulation of floors

Part 7: 1980 (1993) Field measurements of impact sound insulation of floors

Part 8: 1980 (1993) Laboratory measurements of the reduction of transmitted impact noise by floor coverings on standard floor.

Part 9: see BS EN 20140-9: 1994

BS 4142: 1990 Method for rating industrial noise affecting mixed residential and industrial areas.

BS 5363: 1976 (1993) Method for measurement of reverberation time in auditoria

BS 5821 Methods for rating the sound insulation in buildings and of building elements

Part 2: 1984 (1993) Method for rating the impact sound insulation

Part 3: 1984 (1993) Method for rating the airborne sound insulation of facade elements and facades

BS 5969: see BS EN 60651: 1991

BS 6177: 1982 Guide to selection and use of elastomeric bearings for vibration isolation of buildings.

BS 6472: 1992 Guide to evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)

BS 6840 Sound system equipment

Part 16: 1989 Guide to 'RASTI' method for the objective rating of speech intelligibility in auditoria *(IEC 268-16)*

BS 7443: 1991 Specification for sound systems for emergency purposes *(AMD 7675, 6/93)*

BS 7445 Description and measurement of environmental noise *(ISO 1996)*

Part 1: 1991 Guide to quantities and procedures

Part 2: 1991 Guide to the acquisition of data pertinent to land use

Part 3: 1991 Guide to application to noise limits

BS 7482 Instrumentation for the measurement of vibration exposure of human beings

Part 1: 1991 Specification for general requirements for instrumentation for measuring the vibration applied to human beings.

Part 3: 1991 Specification for instrumentation for measuring vibration exposure to the whole body.

BS EN 20140 Acoustics. Measurement of sound insulation in buildings and of building elements

BS EN 20140-2: 1993 Determination, verification and application of precision data

BS EN 60651: 1994 Specification for sound level meters

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Appendix 1 – Glossary

Absorption coefficient
The proportion of sound lost when incident at a surface.

Absorptive attenuator
Attenuator that incorporates glass-fibre and mineral-wool materials, effective over a wide range of frequencies.

Ambient noise
Encompassing sound (at a given place), being usually a composite of sounds from many sources near and far. Should not be confused with "background noise".

Attenuation
Noise reduction.

Attenuator
Noise-reducing device – often colloquially and incorrectly known as a "silencer".

Background noise
Total of interference from all sources in a system used for the production, transmission, detection, measurement or recording of a signal acoustically quantified using L_{90}.

Breakout
The escape of sound from any source-enclosing structure such as ductwork, metal casings and building envelopes.

Broad-band (or random) sounds
Oscillation due to the aggregate of a large number of elementary disturbances randomly occurring in time.

Crosstalk
The transfer of airborne noise from one area to another via secondary air paths such as ventilation ductwork or ceiling voids.

Decibel (dB)
One-tenth of a bel. A bel is the unit of level of a quantity proportional to power when the base of the logarithm is 10. Also, the unit of level of a field quantity when the base of the logarithm is the square root of 10.

dB(A)
Specific measuring scale achieved by a weighting network fitted in a sound level meter. Gives a single-figure rating to a broad-band sound. dB(A) is approximately equivalent to the human ear frequency response.

Dynamic insertion loss (DIL)
A measure of the acoustic performance of an attenuator when handling the rated flow. Not necessarily the same as Static Insertion Loss, because it may include regeneration.

Equivalent continuous sound pressure level (L_{eq})
Logarithm of the ratio of a given root-mean-square sound pressure, during a stated time interval, to the reference sound pressure. Average sound pressure level in decibels is 20 times the logarithm to the base 10 of that ratio. Unless otherwise specified, the reference sound pressure for airborne sound is 20 μPa (20 micropascal).

Excitation frequency
A frequency at which a machine produces vibration. Often the speed of rotation of the machine.

Flanking transmission
Transmission of sound from a source room to an adjacent receiving room but not via the common partition.

Flutter echo
Rapid but nearly even succession of echoes originating from the same sound source. Often occurs in empty rooms. An echo is defined as a sound wave that has been reflected and arrives with such a magnitude and time interval after the direct sound as to be distinguishable as a repetition of it.

Free sound field
Sound field in a homogeneous isotropic medium where boundaries exert a negligible effect on the sound waves.

Frequency (Hz) – sound
The number of sound waves to pass a point in one second.

Frequency (Hz) – vibration
The number of complete vibrations in one second.

Hertz (Hz)
The unit of frequency equivalent to one cycle per second.

Insertion loss
The reduction of noise level by the introduction of a noise control device; established by the substitution method of test.

Insulation (sound)
The property of a material or partition of opposing sound transfer through its thickness.

Inverse square law
The reduction of noise with distance. In terms of decibels, it means a decrease of 6 dB for each doubling of distance from a point source when no reflective surfaces are present.

Isolation (vibration)
The reduction of vibrational force into a structure.

Isolation efficiency
The amount of vibration force absorbed by an isolator and thus prevented from entering the supporting structure, expressed as a percentage of the total force applied to the isolator.

L_{eq}
See "Equivalent continuous sound pressure level"

$L'_{nT,w}$
See "Weighted standardised impact sound pressure level"

L_{90}
See "Background noise"

Masking noise or sound conditioning
Extra noise introduced into an area to reduce the variability of fluctuating noise levels and improve the intelligibility of speech.

Mass law
Heavy materials stop more noise passing through them than light materials. For any airtight material there will be an increase in its "noise-stopping" ability of approximately 6 dB for every doubling of mass per unit area.

Natural frequency
Frequency of free oscillation of a system. For a multiple-degree-of-freedom system, the natural frequencies are the frequencies of the normal mode of oscillation.

Near sound field
Sound field near a sound source where instantaneous sound pressure and particle velocity are substantially out of phase. The inverse square law does not apply in the near sound field.

Noise
1. Erratic or statistically random oscillation.
2. Disagreeable or undesired sound or other disturbance.

Noise criterion (NC) curves
A US set of curves based on the sensitivity of the human ear. They give a single figure for broad-band noise. Used for indoor design criteria. They are similar to NR curves but have different frequency characteristics.

Noise rating (NR) curves
A set of curves based on the sensitivity of the human ear. They are used to give a single-figure rating for a broad band of frequencies. Used for interior design criteria. They are similar to NC curves but have different frequency characteristics.

Noise reduction
Used to define the performance of a noise barrier. Established by measuring the difference in sound pressure levels adjacent to each surface. (See also Sound Reduction Index)

Octave
Unit of logarithmic frequency interval: two sounds, the ratio of whose fundamental frequencies is 2, have a logarithmic frequency interval of 1 octave.

Octave bands
A convenient division of the frequency scale. Identified by their centre frequency, typically 63, 125, 250, 500, 1000, 2000, 4000, 8000 Hz.

Periodic sounds
A signal containing a finite number of pure tones which repeats itself at regular intervals.

Pure tone
Sinusoidal acoustic oscillation.

Reactive attenuator
An attenuator in which the noise reduction is brought about typically by changes in cross-section, chambers and baffle volumes, for example a car exhaust silencer.

Regeneration
The noise generated by airflow turbulence. The noise level usually increases with flow speed.

Resonance
State of a system in forced oscillation such that any changes, however small, in the frequency of excitation result in a decrease in a response of the system.

Resonant frequency (Hz)
Frequency at which resonance exists.

Reverberation
The sound that persists in an enclosed space, as a result of repeated reflection or scattering, after the source of the sound has stopped.

Reverberation time
Of an enclosure, for a sound of a given frequency or frequency band. The time that would be required for the sound pressure level in the enclosure to decrease by 60 dB, after the source has been stopped.

Room constant
The sound-absorbing capacity of a room, usually expressed in m^2.

R'_w
See "Weighted apparent sound reduction index"

Sabine's formula
Predicts the reverberation time of a room or enclosure from known room volume and absorption characteristics. Becomes inaccurate when absorption is high.

Silencer
Colloquialism for attenuator.

Solid state (bottoming)
Vibration isolation, that is, when a spring can be compressed no further and the coils are in contact.

Sound insulation
The property of a material or partition to oppose sound transfer through its thickness.

Sound level meter (noise meter)
An instrument for the measurement of sound level, with a standard frequency weighting and standard exponentially-weighted time-averaging.

Sound power
A measure of sound energy in watts. A fixed property of a machine, irrespective of environment.

Sound power level (L_W)
Logarithm of the ratio of a given sound power to the reference sound power. Power level in decibels is ten times the logarithm to the base 10 of the ratio. Unless otherwise specified, the reference sound power is 1pW.

Sound pressure level (L_p)
Logarithm of the ratio of a given sound pressure to the reference sound pressure. Sound pressure level in decibels is 20 times the logarithm to the base 10 of the ratio. Unless otherwise specified, the reference sound pressure is 20 μPa for airborne sound and 1 μPa for a sound in media other than air. Unless otherwise specified, the sound pressures are understood to be expressed in root-mean-square values.

Sound reduction index (SRI)
Of a partition, for a specified frequency band. Difference in decibels between the average sound pressure levels in the reverberant source and receiving rooms, plus ten times the logarithm to the base 10 of the ratio of the area of the common partition to the total sound absorption in the receiving room.

Sound spectrum
Representation of the magnitudes (and sometimes of the phases) of the components of a complex sound as a function of frequency.

Speech transmission index (STI)
A specialised design and measurement parameter used for the quantification of audio systems. A high value STI indicates a high degree of speech intelligibility.

Standing wave
Periodic wave having a fixed distribution in space that is the result of interference of progressive waves of the same frequency and kind. Such waves are characterised by the existence of nodes or partial nodes and antinodes that are fixed in space.

Static deflection
The distance that vibration isolators compress when loaded.

STI
See "Speech transmission index"

Third-octave bands
A small division of the frequency scale, three to each octave. Enables more accurate noise analysis.

Transmissibility
The amount of vibratory force that is transferred to the structure through an isolator, expressed as a percentage of the total force applied.

Turbulent flow
A confused state of airflow that may cause noise to be generated inside, for example, a ductwork system.

Vibration dose value (VDV)
A parameter used to reflect the disturbance and/or annoyance caused by variable vibration.

Vibration isolation
Any of several means of reducing the transfer of vibrational force from the mounted equipment to the supporting structure, or vice versa.

Wavelength
The distance between two like points on a wave shape, for example distance from crest to crest.

Weighted apparent sound reduction index (R'_w)
A single-number index which characterises the frequency-dependent airborne sound insulation performance of building elements.

Weighted standardised impact sound pressure level ($L'_{nT,w}$)
A single-number index which characterises the frequency-dependent impact sound insulation performance of building elements.

Other publications in this series

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1 Anti static precautions: rubber, plastics and fabrics†
2 Anti static precautions: flooring in anaesthetising areas (and data processing rooms), 1977.
3 –
4 –
2005 Building management systems*
6 Protection of condensate systems: filming amines†
2007 Electrical services: supply and distribution, 1993.
8 –
2009 Pneumatic air tube transport systems, 1995.
2010 Sterilizers, 1994, 1995.
2011 Emergency electrical services, 1993.
12 –
13 –
2014 Abatement of electrical interference, 1993.
2015 Bedhead services, 1994, 1995.
16 –
17 Health building engineering installations: commissioning and associated activities, 1978.
18 Facsimile telegraphy: possible applications in DGHs†
19 Facsimile telegraphy: the transmission of pathology reports within a hospital – a case study†
2020 Electrical safety code for low voltage systems, 1993.
2021 Electrical safety code for high voltage systems, 1993, 1994.
2022 Medical gas pipeline systems, 1994.
2023 Access and accommodation for engineering services, 1995.
2024 Lifts, 1995.
2025 Ventilation in healthcare premises, 1994.
26 Commissioning of oil, gas and dual fired boilers: with notes on design, operation and maintenance†
2027 Hot and cold water supply, storage and mains services, 1995.
28 to 29 –
2030 Washer-disinfectors, 1995.
2031 Steam supply for sterilization*
32 to 34 –
2035 Mains signalling*
36 to 39 –
2040 The control of legionellae in healthcare premises – a code of practice, 1993.
41 to 49 –
2050 Risk assessment in the NHS estate, 1994.
51 to 54 –
2055 Telecommunications (telephone exchanges), 1994.

Component Data Base (HTMs 54 to 80)

54.1 User manual, 1993.
55 Windows, 1989.
56 Partitions, 1989.
57 Internal glazing, 1995.
58 Internal doorsets, 1989.
59 Ironmongery†
60 Ceilings, 1989.
61 Flooring, 1995.
62 Demountable storage systems, 1989.
63 Fitted storage systems, 1989.
64 Sanitary assemblies, 1995.
65 Health signs*
66 Cubicle curtain track, 1989.
67 Laboratory fitting-out system, 1993.
68 Ducts and panel assemblies, 1993.
69 Protection, 1993.
70 Fixings, 1993.
71 Materials management modular system*
72 to 80 –

Firecode

81 Firecode: fire precautions in new hospitals*
81 Supp 1, 1993.
82 Firecode: alarm and detection systems, 1989.
83 Fire safety in healthcare premises: general fire precautions, 1994.
85 Firecode: fire precautions in existing hospitals, 1994.
86 Firecode: fire risk assessment in hospitals, 1994.
87 Firecode: textiles and furniture, 1993.
88 Fire safety in health care premises: guide to fire precautions in NHS housing in the community for mentally handicapped/ill people, 1986.

New HTMs in preparation

2030 Washers for sterile production

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